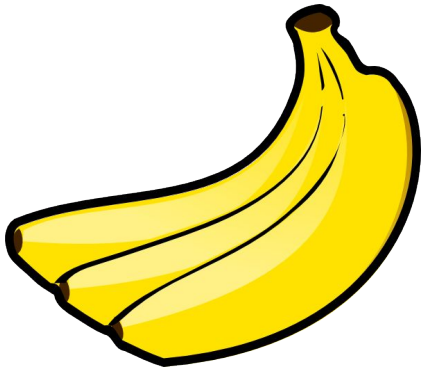
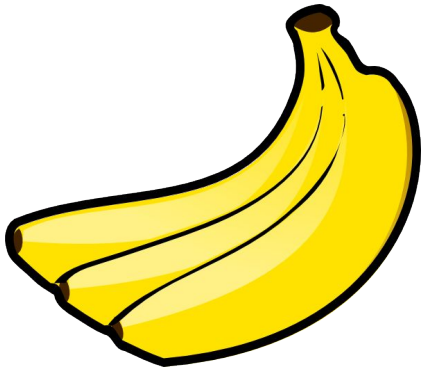
A Farmboy's Guide to (Dinging) the Galaxy

Types of objects in the world

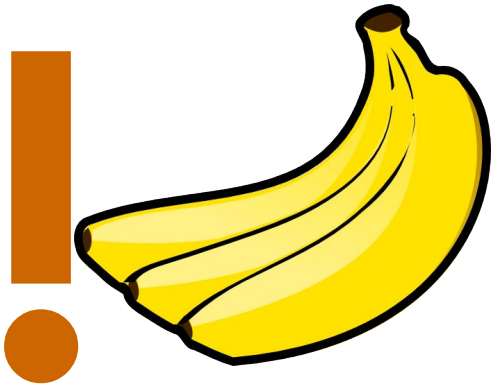


Banana

Types of objects in the world
(with a particular focus on a particular object)



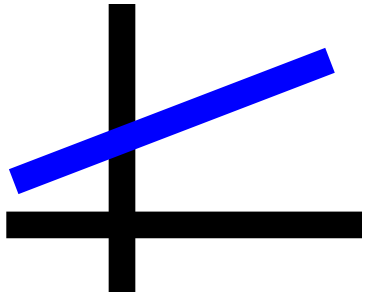
Banana



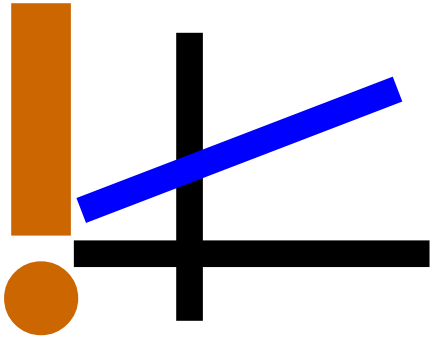
Non-banana

Types of models

(Yes, there's a bit of bias in focus here!)



Linear



Nonlinear

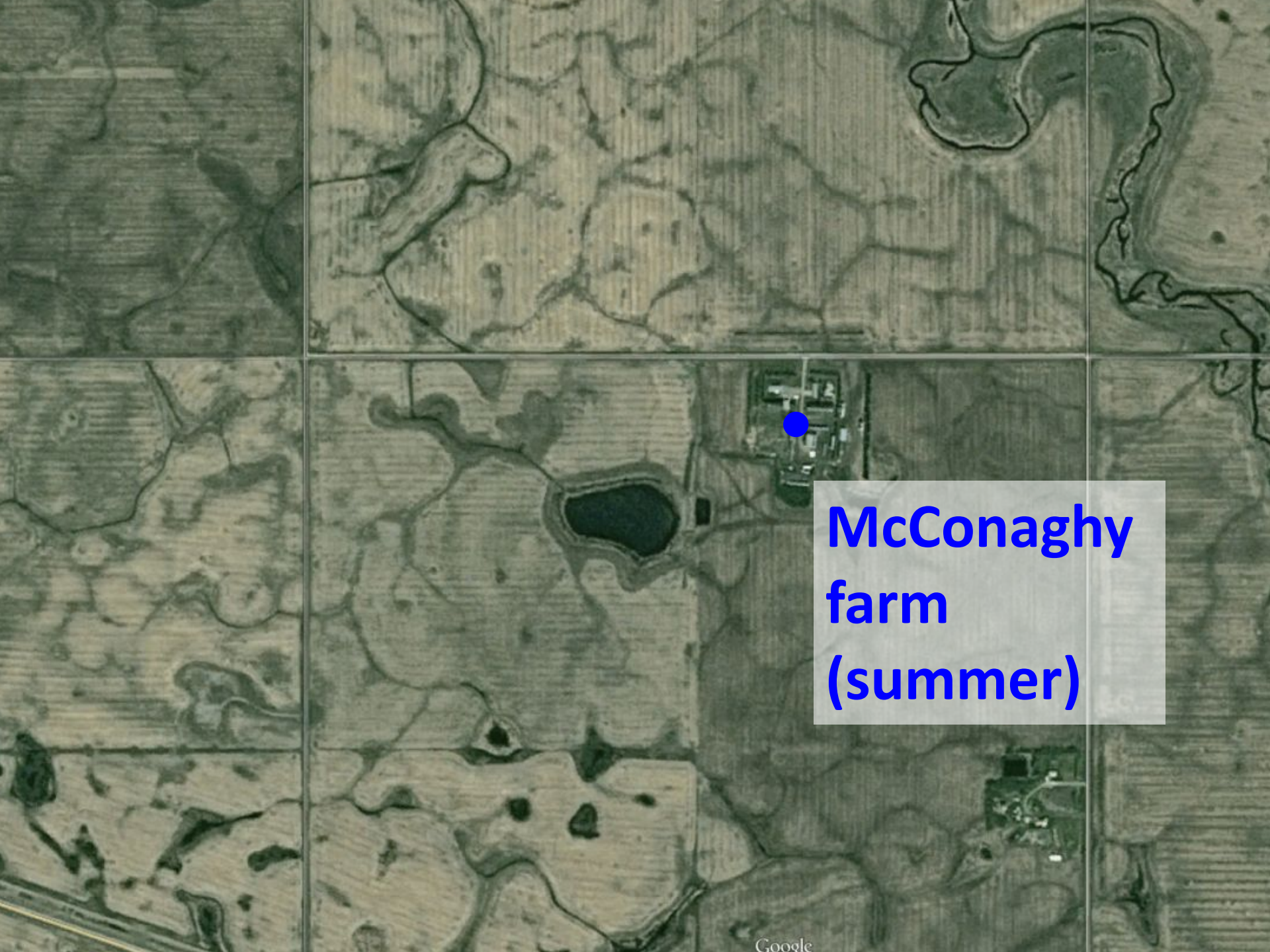
Types of life events
(With a particular focus)

Key turning point

Rest of life


Gulf of Alaska
Hudson Bay
Canada
Gulf of St Lawrence
North Pacific Ocean
North Atlantic Ocean
Canada
United States


Saskatchewan, Canada
McConaghy farm
Yukon
Hudson Bay
Alberta
Manitoba
British Columbia
Saskatchewan
Edmonton
Calgary
Winnipeg
Ontario
Quebec
Newfoundland and Labrador
Vancouver
Gulf of St Lawrence
Seattle
Washington
Montana
North Dakota
Minnesota
Portland
Oregon
Idaho
Wyoming
South Dakota
Minneapolis
Wisconsin
Michigan
Toronto
Milwaukee
Hamilton
Detroit
Chicago
Cleveland
Ottawa
Montreal
Maine
Vermont
New Hampshire
New York
Massachusetts
Connecticut
Pennsylvania
Ohio
Nebraska
Iowa
Illinois
Indiana
Columbus
Maryland
Philadelphia
Delaware
Nevada
Utah
Colorado
Denver
United States
Kansas City
Indianapolis
Cincinnati
West Virginia
Washington
Sacramento
San Francisco
San Jose
California
Kansas
Missouri
St. Louis
Kentucky
Virginia
Las Vegas
Albuquerque
Oklahoma
Arkansas
Tennessee
North Carolina
Charlotte
Los Angeles
Arizona
New Mexico
Atlanta
South
Google


McConaghy farm (summer)
Google

- McConaghy farm (winter)


110
110

canada.com

Irkutsk! It's colder than Siberia

People looking for respite from the cold in Saskatchewan might want to consider a vacation in Siberia.

BY THE STARPHOENIX (SASKATOON) JANUARY 30, 2008

People looking for respite from the cold in Saskatchewan might want to consider a vacation in Siberia.

The northern region of Russia, known as one of the coldest places on Earth, was a comparatively balmy -28 C in Irkutsk on Tuesday. In Saskatoon the morning temperature was -37 -- but after factoring in the extreme wind chill it was -51.

In Regina, and a number of other provincial locales, the wind-chilled temperature topped out at -52. It was -57 in Meadow Lake, -54 in La Ronge and Uranium City earned the ignominious distinction of being the coldest place on the continent -- and possibly the entire planet -- at -59.

"I did some searching and it (Uranium City) is the champ in North America for sure. There was nowhere colder," said Environment Canada meteorologist Bob Cormier.

Second place also goes to a Saskatchewan, as the mining settlement of Key Lake checked in at a numbing -58. It tied Fort Yukon, the coldest place in Alaska, on Tuesday.

It's not possible, without large amounts of free time, to research the location of every weather station on the globe to find a colder place. A quick check of sites closest to the polar tips of the Earth and barren tracts of land known for their inhospitable conditions didn't reveal a single one more frigid than

Pigs @ McConaghy farm

Grain @ McConaghy farm

Career Planning as a 12 Year Old (1989)

Passions:

"I love programming"

"I love to build stuff"

"Artificial Intelligence is cool (and it feels like it could change *everything*)"

Constraints?

"You and your two brothers will be taking over the farm"

Working plan:

"I'll study Agricultural Engineering at the local university, then come back and farm"

(Notice a discrepancy here?)

Career Planning as a 15 Year Old (1992)

Passions:

"I love programming"

"I love to build stuff"

"Artificial Intelligence is cool"

Constraints?

~~"You and your two brothers will be taking over the farm"~~

"Dad, there's a chance I won't farm." **

Working plan:

~~"I'll study Agricultural Engineering, then farm"~~

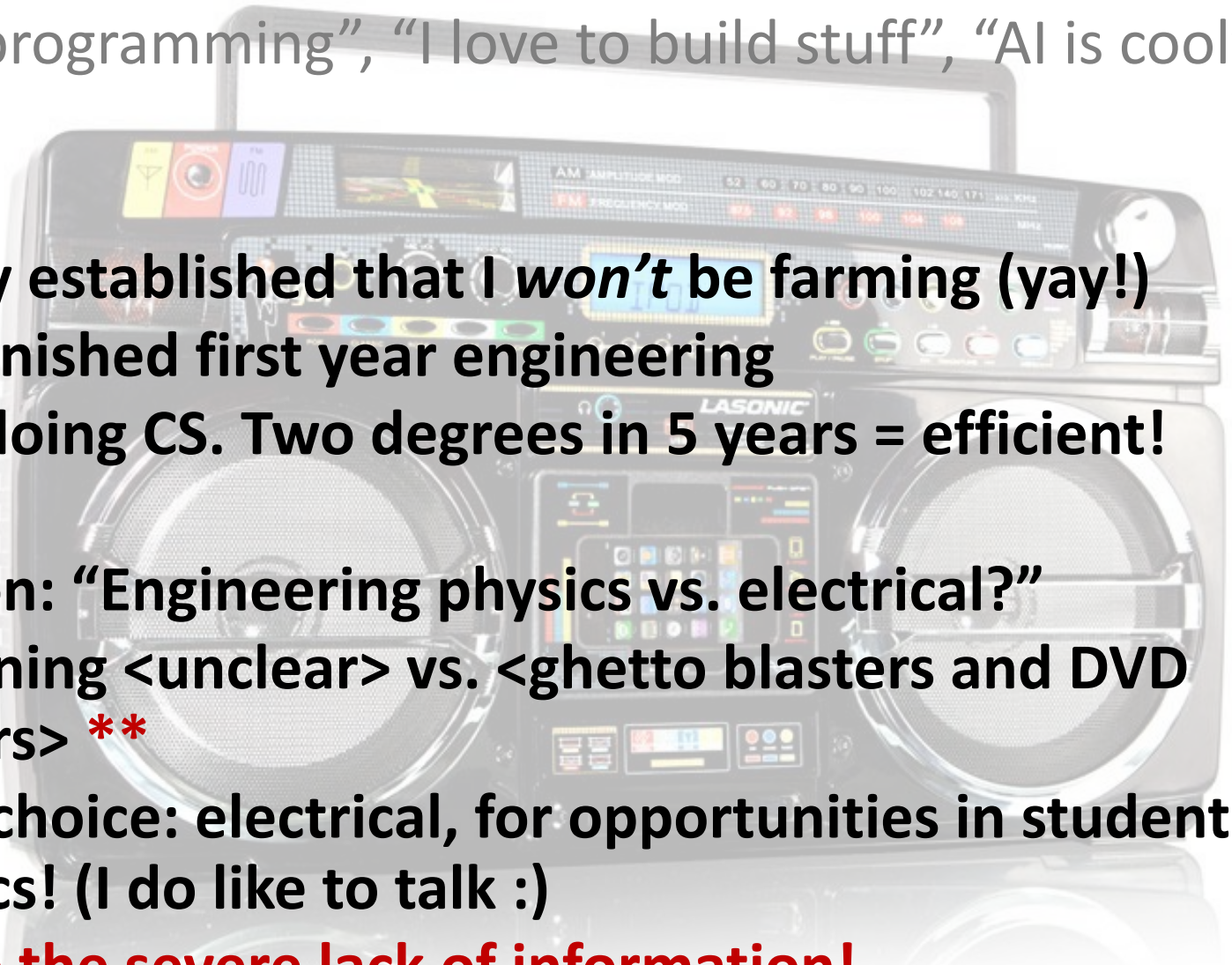
"I'll study Engineering, but maybe it won't be Agricultural"

**** This was *super* hard to tell my father.**

Career Planning as an 18 Year Old (1995)

Passions:

"I love programming", "I love to build stuff", "AI is cool"



Status:

- **Firmly established that I *won't* be farming (yay!)**
- **Just finished first year engineering**
- **Also doing CS. Two degrees in 5 years = efficient!**

Question: "Engineering physics vs. electrical?"

- **Designing <unclear> vs. <ghetto blasters and DVD players> ****
- **Final choice: electrical, for opportunities in student politics! (I do like to talk :)**

**** Note the severe lack of information!**

Career Planning as an 18.5 Year Old (2nd year EE) (1995)

Passions:

"I love programming", "I love to build stuff", "AI is cool"

Question: "How exactly do I get into AI?"

- No idea!
- *But* I did discover that I could subscribe to IEEE Transactions on Neural Networks. (Yay! Bedtime **reading**)
- I also discovered the periodicals in the engineering library. (Yay! 1994 Genetic Programming workshop!)
- Also for fun, I learned C/C++, played with NNs

Career Planning as a 19 Year Old (3rd year EE) (1996-97)

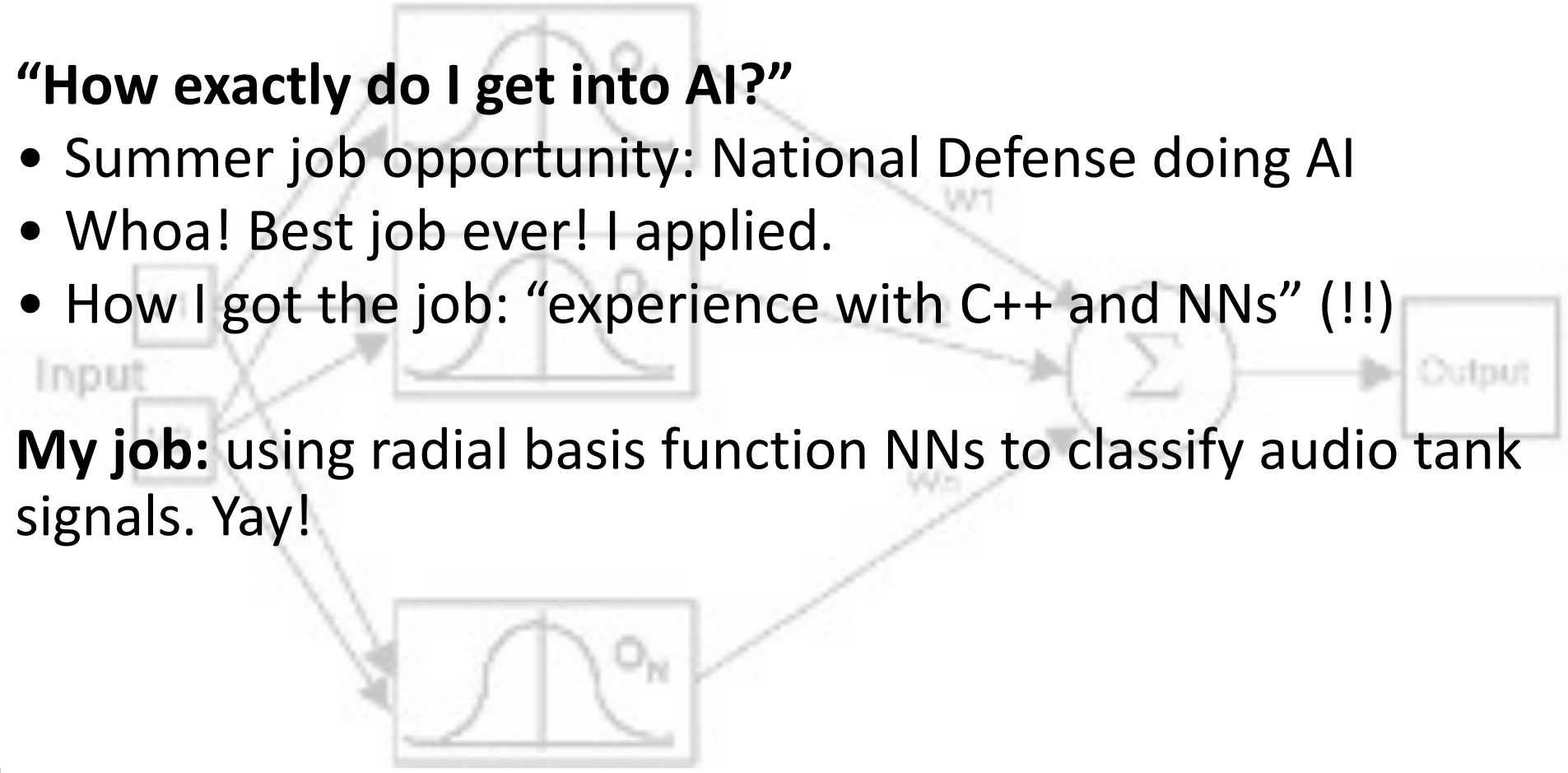
Passions:

"I love programming", "I love to build stuff", "AI is cool"

"How exactly do I get into AI?"

- Summer job opportunity: National Defense doing AI
- Whoa! Best job ever! I applied.
- How I got the job: "experience with C++ and NNs" (!!)

My job: using radial basis function NNs to classify audio tank signals. Yay!



Career Planning as a 20 Year Old (4th year EE) (1997-98)

Passions:

"I love programming", "I love to build stuff", "AI is cool"

New data points:

- Class on analog circuits. Manual, creative, math. Yay!
- Saw just-published IEEE Trans. on Evolutionary Computation 1(1). Had paper on *auto* design of analog circuits! (using Genetic Programming - GP)
  - First thought: agh, I'll be obsolete!
  - Second thought: **perhaps *I* can do AI-based design?**

My next summer job: back at National Defense. But this time: I did GP, went to a GP conference, met GP people!

Career Planning as a 21 Year Old (5th year EE) (1998)

Passions:

"I love programming", "I love to build stuff", "AI is cool", "Startups are cool" (this was 1998)

"What to do after grad?"

- **PhD on AI, vs start a company, vs get a job**

"What to do for final-year team design project?"

Chose (with five colleagues):

- **Start a company using design project**
- **As backup, line up funding for PhD**

How I spent my final year of undergrad (1998-99)

- Chose a project:
  - Brainstormed 50 ideas, filtered on potential etc.
  - Ended up with (perhaps unsurprisingly) AI for circuits
  - Prof: “No chance. I’ll buy you steak dinners if you can do this.” Another: “If it could be done it would have been done already”. The gauntlet was thrown..
- Bought time: no class, just textbooks. Project 40-60 h/wk
- Built it! 10x state-of-the art! Free steaks!
  - We presented our design project as a *company*, calling it “Analog Design Automation Inc.”
- Got full PhD funding too. (For AI research of course ☺️)
- And then the project became the company, for real…

Analog Design Automation Inc. (1999-2004)

Corporate history:

- Incorporated the day after last final exam
- 1999 - $50K gov't grant
- 1999 - $500K seed
- 2000 - $8M series A from Intel & other VCs
- 2002 - $2.5M series B
- Grew from 6 to 30 people. ("Valuation α headcount")
- **Early 2004 – sold company**

Analog Design Automation Inc. (1999-2004)

Tech history:

- Initial "product" optimized topology + parameters
- Discovery: Designers hesitate to adopt it because of *trust*.
- Discovery: as a 1st cut, customers only needed to optimize parameters. Sol'n: just optimize in Euclidian space (easier)
- Discovery: scalability matters more than optimality. Solution: global → local opt. (easier yet!). Became an edge.
- Discovery: the right visualization *really* matters. Built an adjacent product. It became an edge.

- Personal realization: Moore's Law *really* matters to humanity. Backbone of other tech, and econ. growth

Life & Career Thoughts as a 27 Year Old (2003)

"My feet are itchy. I'm a bit bored at what I'm doing."
"I'd love to travel the globe"
"I'd love to live in Europe"
"I'd love to live on a beach and surf all the time"
"I'd love to write a novel"
"I'm a researcher at heart. A PhD would be cool."
"I'd love to make analog synthesis trustworthy."
"Neuro is cool (feels like it could change *everything*)"

While still..
"I love programming"
"I love to build stuff"
"AI is cool (feels like it could change *everything*)"
"Startups are cool (esp. as a means to an end: neuro..)"

Life & Career *Planning* as a 27 Year Old (2003)

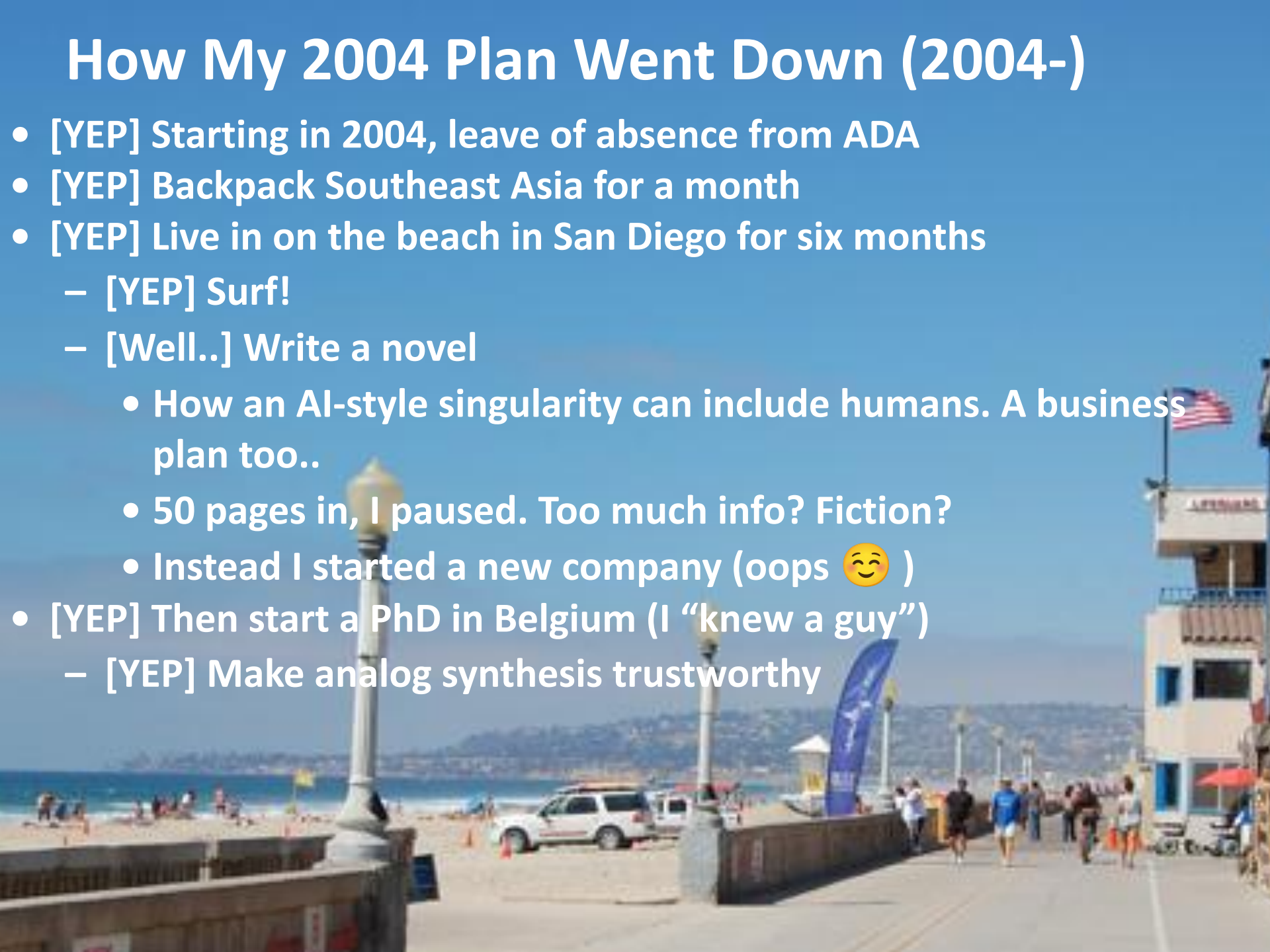
I *designed* the following plan
It resolved all my goals!!

- Starting in 2004, leave of absence from ADA
- Backpack Southeast Asia for a month
- Live in on the beach in San Diego for six months
  - Surf!
  - And write a novel
- Then start a PhD in Belgium (I “knew a guy”)
  - Make analog synthesis trustworthy

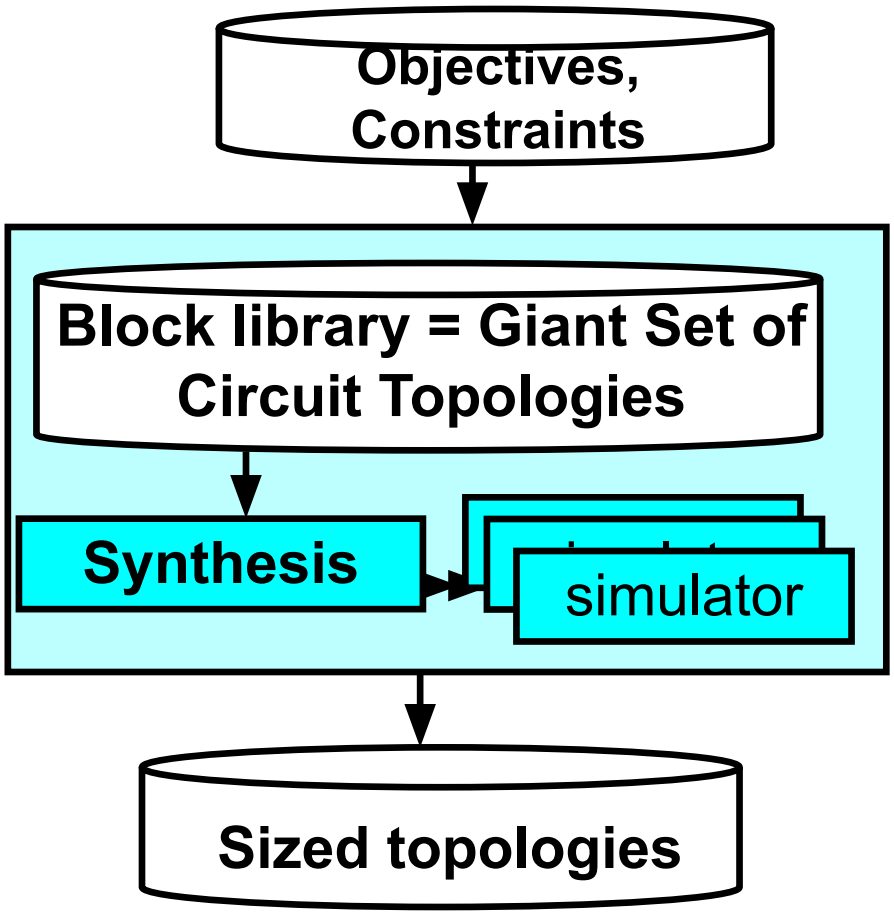
(Neuro can wait, startups can wait)

How My 2004 Plan Went Down (2004-)

- [YEP] Starting in 2004, leave of absence from ADA
- [YEP] Backpack Southeast Asia for a month
- [YEP] Live in on the beach in San Diego for six months
  - [YEP] Surf!
  - [Well..] Write a novel
    - How an AI-style singularity can include humans. A business plan too..
    - 50 pages in, I paused. Too much info? Fiction?
    - Instead I started a new company (oops ☺️)
- [YEP] Then start a PhD in Belgium (I “knew a guy”)
  - [YEP] Make analog synthesis trustworthy



2004-2008: PhD (1/3): MOJITO Flow



Core idea: Embed existing knowledge in a library of trusted circuit blocks.

Equivalently: the library is a *grammar*. Therefore a circuit is a *sentence* in the grammar.

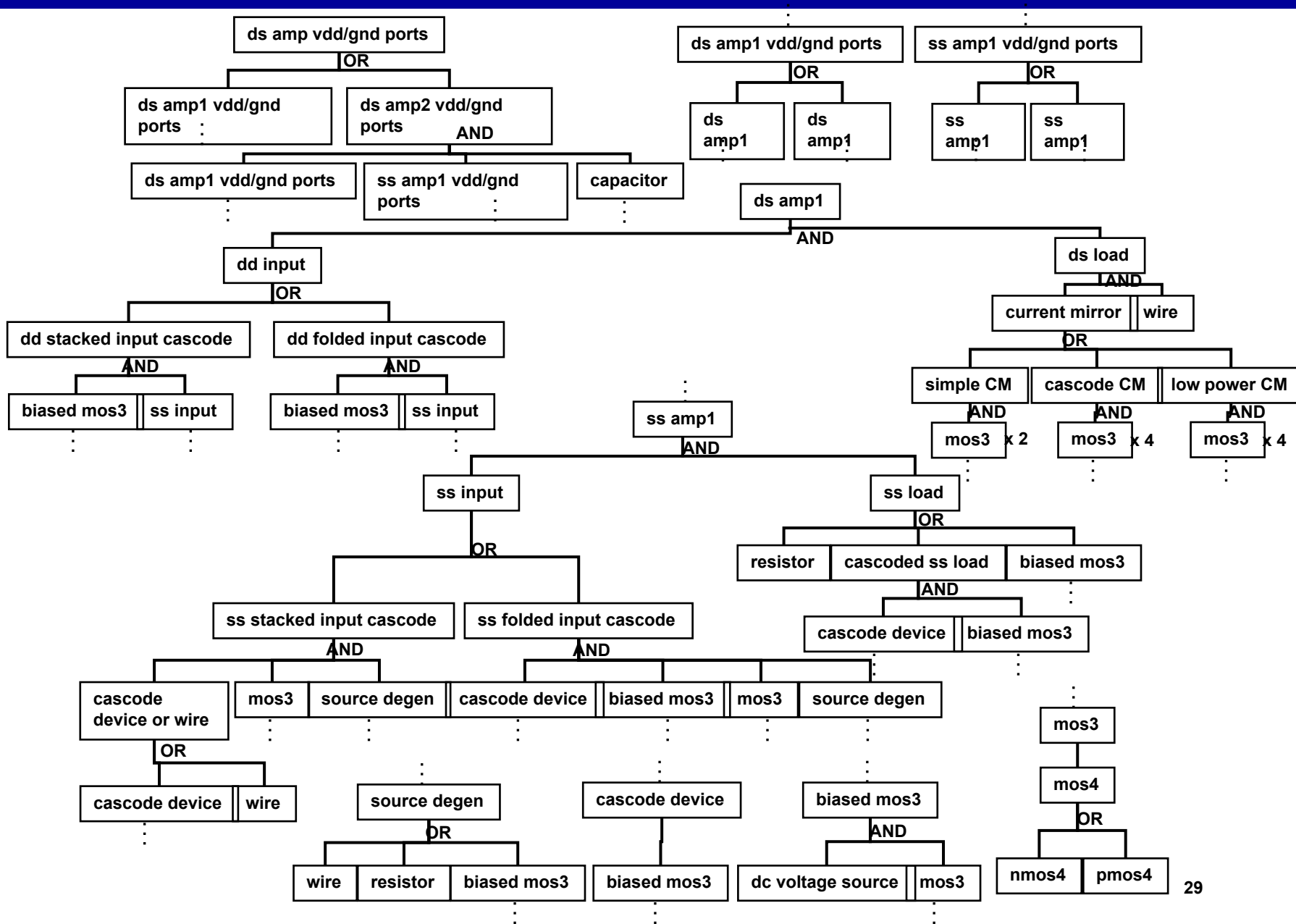
Challenges:

(a) design the grammar. Solve via tearing hair out.

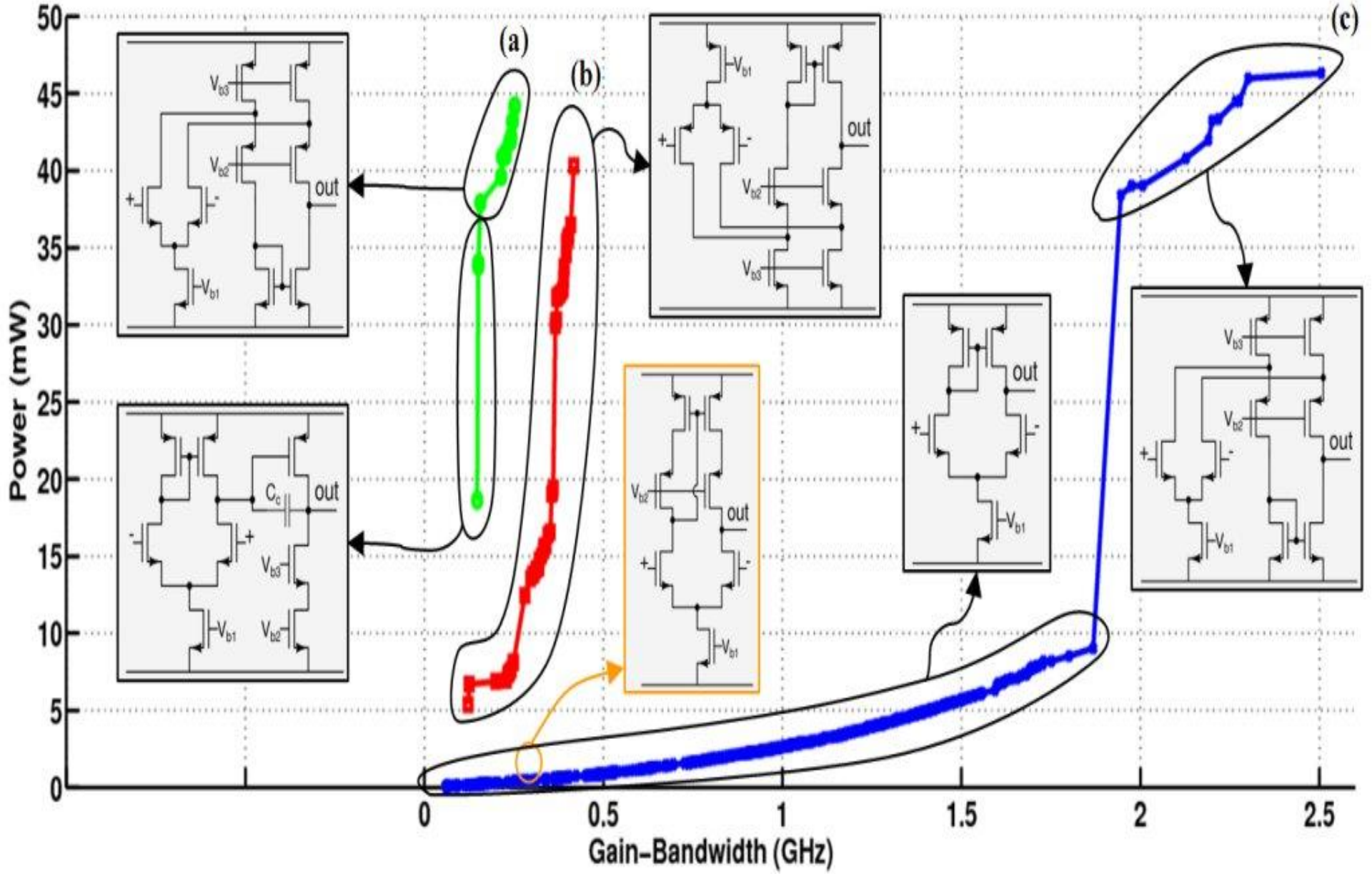
(b) populate it. Solve via mining textbooks and papers.

(c) search it. Solve via Genetic Programming++

2004-2008: PhD (2/3): 35 Blocks → 100K+ topologies!



2004-2008 PhD (3/3) Some results: it automatically synthesized these structures & parameters.



Solido Design Automation Inc. (2004-now)

Corporate history:

- 2004 – research on the beach (surf in am, invent in pm)
  - I realized: in time, variation could kill Moore's law.
  - I could be waiting with software to save the day☺️
  - I built an AI-based prototype to demonstrate. (Efficiency+ compared to undergrad!)
  - My biz partner found lead customers. Then investors.
- 2005 - $2M series A
- 2006 - $7.5M series B
- Profitable. Half of top 20 semis as customers (Sony, Nvidia, Qualcomm, Huawei, ..)

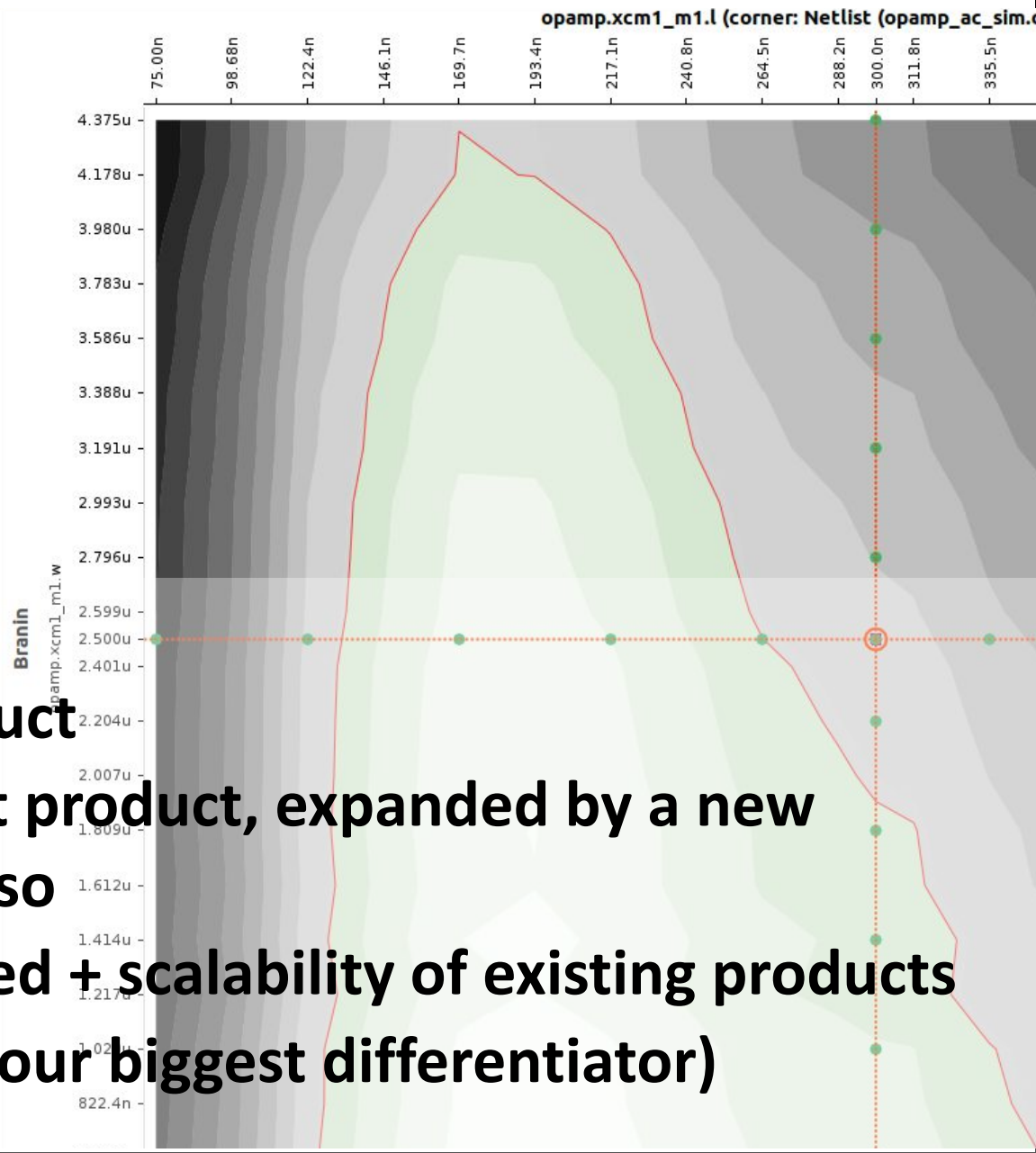
Solido Design Automation Inc. (2004-now)

Name	Simulated	Cost	Area	AllVa
Initial (ID=0)	True	3.928	53.50p	137.6u
Best (ID=277)	True	1.831	3.418p	34.52u
Explore (ID=0)	True	3.928	53.50p	137.6u
Best (1) (ID=-1)	False	2.469	6.482p	64.28u
Best (2) (ID=-6)	False	2.379	6.722p	65.89u

Save netlist... Compare... Simulate

Impacts on: Branin

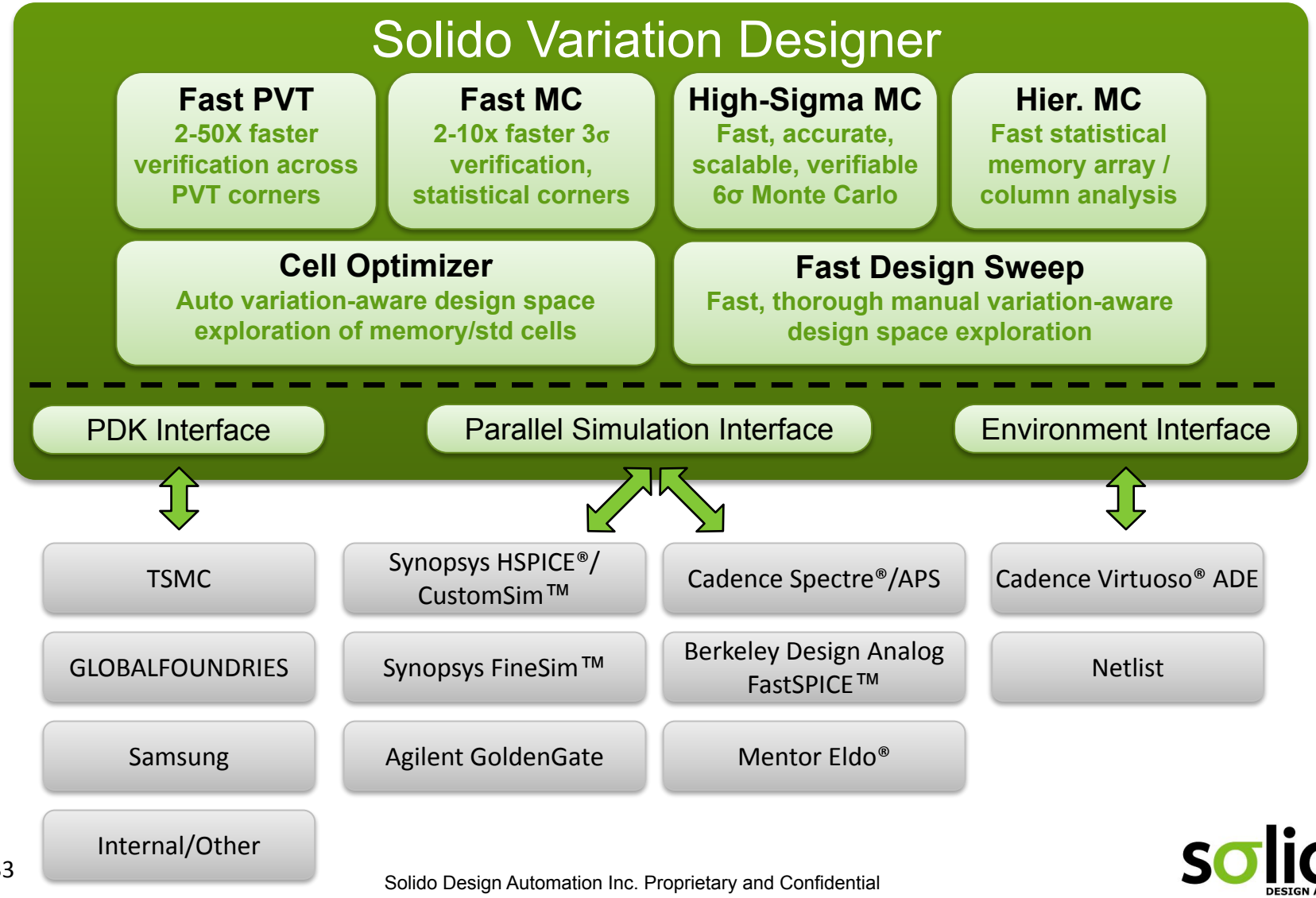
Impact	Variables	Value (Explore)
58.48%	opamp.xcm1_m1.l	300.0n
28.79%	opamp.xcm1_m1.w	2.500u
12.74%	opamp.xcm1_m1.l, opamp.xcm1_m1.w	300.0n, 2.500u



Tech history:

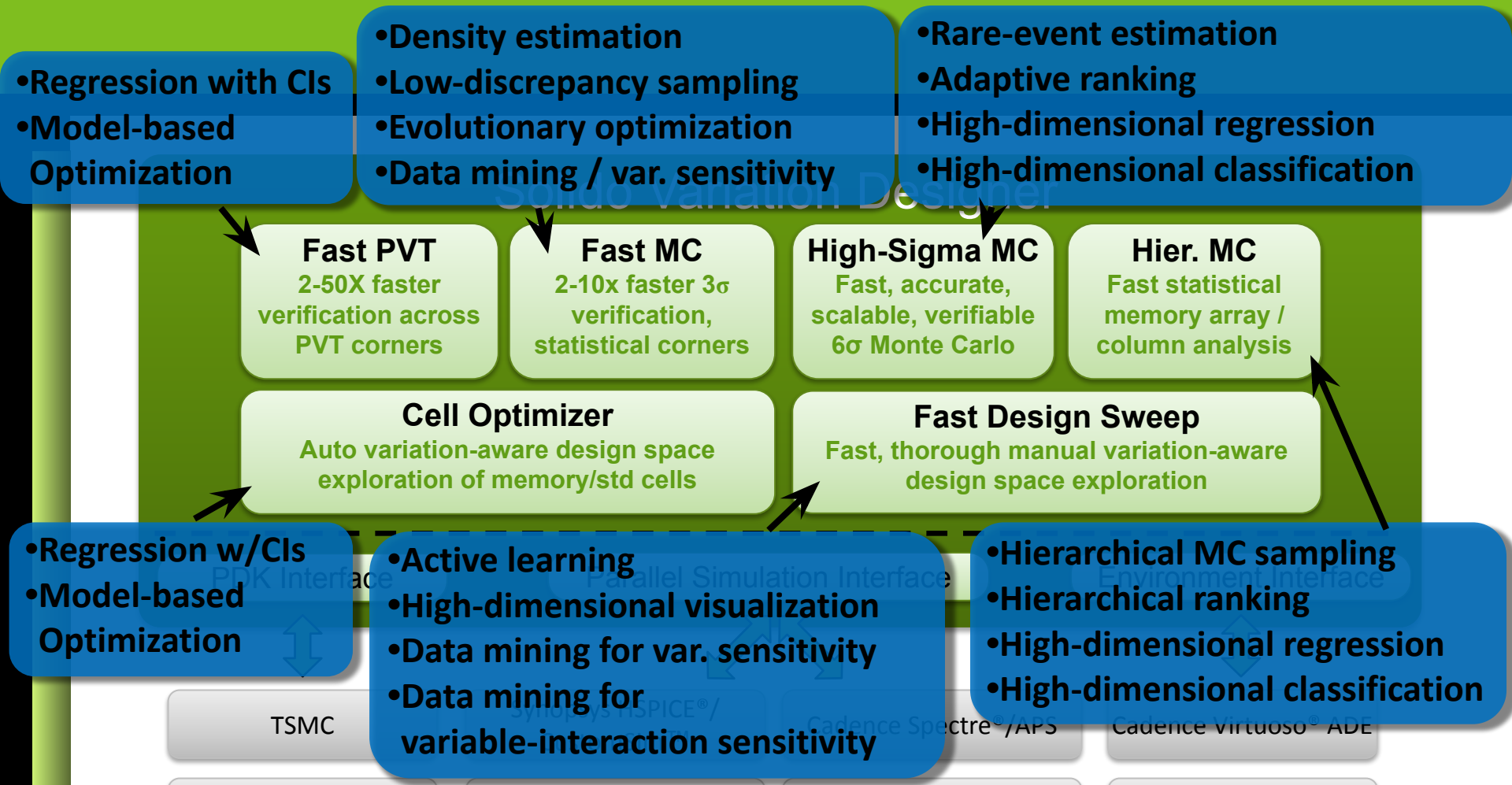
- Started with one product
- Once success with first product, expanded by a new product every year or so
- Always improving speed + scalability of existing products
- AI at the core of it all (our biggest differentiator)

Solido Product Overview



solido DESIGN AUTOMATION

AI/ML In Solido Products

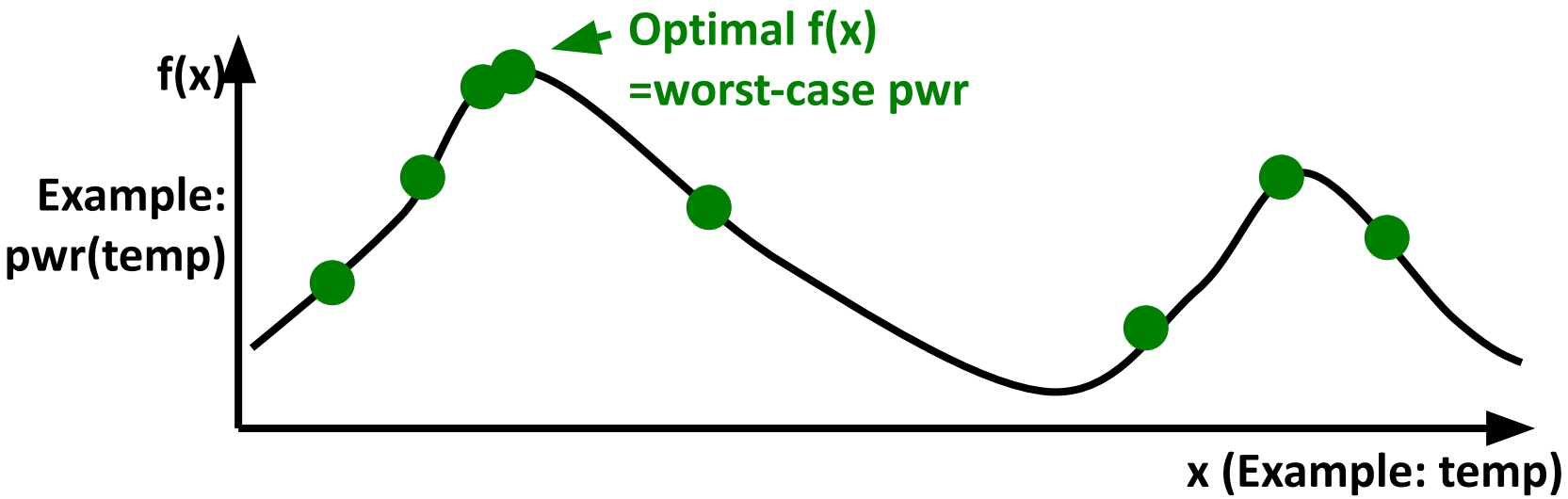


Example: Solido Fast PVT

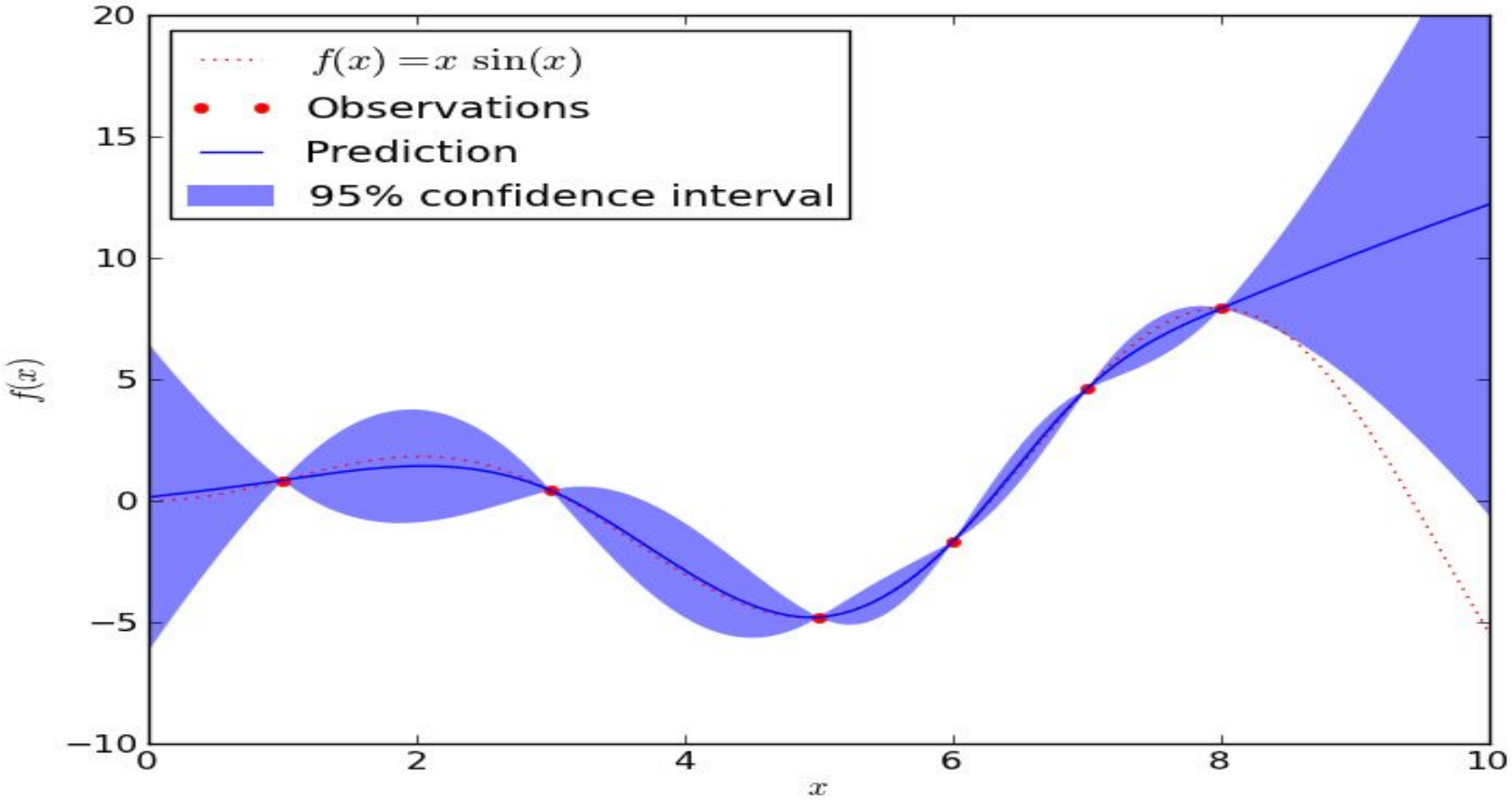
Cast PVT verification as a global optimization problem:

- **Search through space of "corners" - x**
- **Minimize / maximize simulated output value f(x)**

Then, solve the optimization problem reliably.



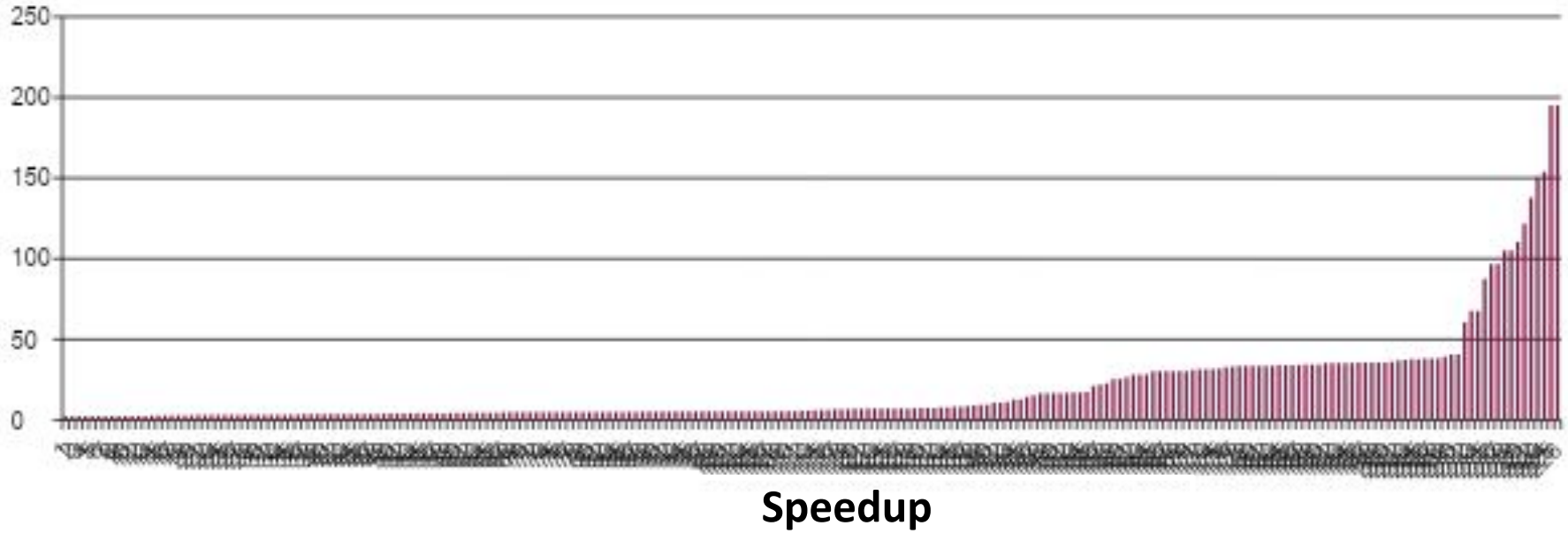
Fast PVT Underlying Model



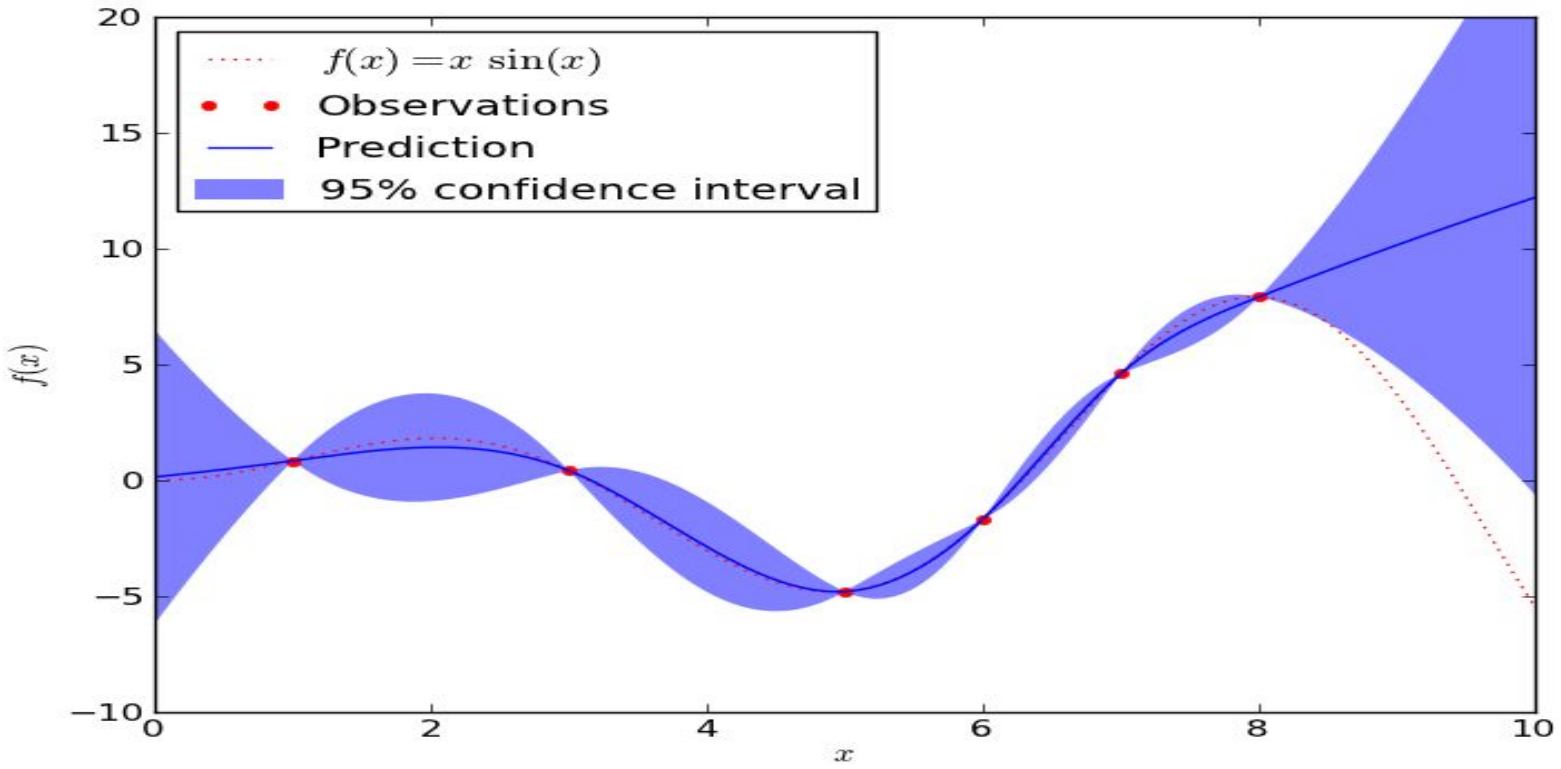
- Typically a Gaussian Process Model (GPM)
  - Natural interpolator
  - Convenient confidence intervals
  - Well-behaved, no crazy extrapolation (usually)

Benchmarks on 226 Circuit PVT Verification Problems

- 226 test cases in benchmark suite:
  - From Solido customers, in-house realistic cases, and in-house corner cases targeting challenging problems
  - Many contain complex interactions, non-linearities, discontinuities, etc.
- **226/226 (100%) of cases find true optimum**
- Speedup **2.34X to 226X**
- **Median speedup is 22X**

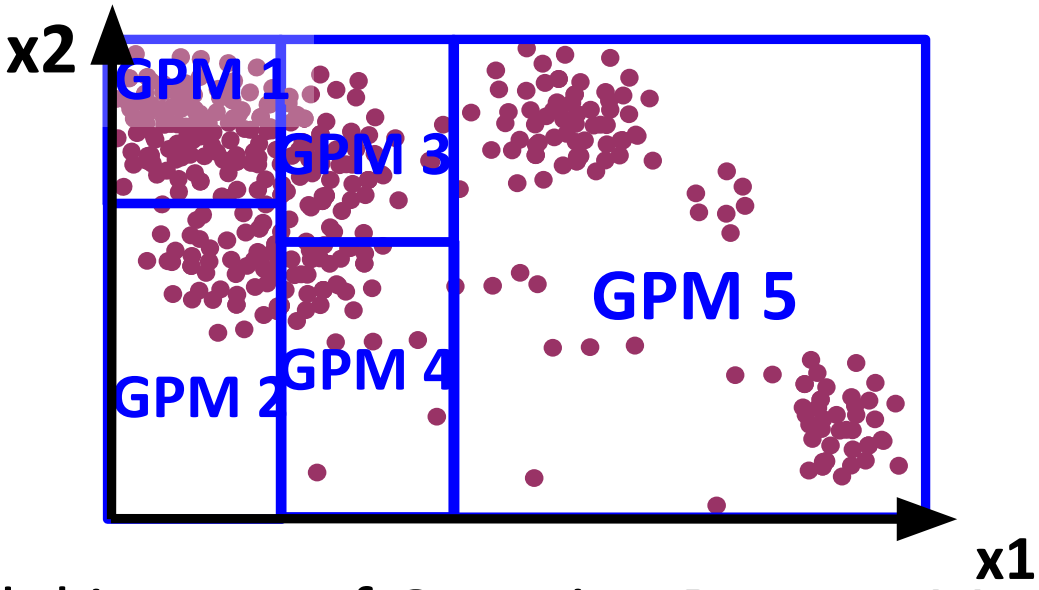


Fast PVT Scalability Challenge: # Samples



- **Problem: GPM training is O(N^3) on # Training Samples**
- **Becomes *very* unhappy when >1000 samples**
- This happens for circuit verification problems with larger # dimensions and highly nonlinear circuit
- First solution: just cut loose and sim all
- Is there a better way?

Fast PVT Solution: Divide-and-Conquer on Training Samples



- New model is a *set* of Gaussian Process Models (GPM)
- One GPM for each region of input x space
- Regions are automatically determined at build time
  - Via classic CART learning
  - Stop at a leaf when <700 samples
- Build a GPM on each leaf's samples (and *k* neighbors)
  - Each GPM is O(1) on # training samples because N=const
  - CART learning is O(N log N) on # samp with tiny constant

Benchmarking: GPM vs Divide-and-Conquer GPM

				GPM			Divide-and-conquer GPM		
Problem	# vars	# train pts	# test pts	Build Time (s)	Test Time (s)	Error	Build Time	Test Time	Error
Low-dimensional									
opamp-pvt-bandwidth	10	4425	1475	667.4	91.1	0.044	**55.6**	**7.4**	**0.006**
opamp-pvt-dc_gain	10	4425	1475	741.9	91.5	**0.001**	**57.9**	**8.5**	**0.003**
opamp-pvt-gain_margin	10	4425	1475	319.9	92.2	0.313	**59.6**	**8.2**	**0.168**
opamp-pvt-gbw	10	4425	1475	845.7	92.8	**0.010**	**62.4**	**8.8**	**0.008**
opamp-pvt-idc	10	4425	1475	775.2	91.7	**0.000**	**41.2**	**8.2**	**0.000**
opamp-pvt-phase_margin	10	4425	1475	268.2	90.9	**0.149**	**49.8**	**6.6**	**0.155**
High-dimensional									
senseamp_pwr	125	3750	1250	failed	failed	failed	**165.8**	**37.9**	**4.139**
opamp_AV	215	600	200	38.3	18.2	**2.933**	**23.3**	**9.8**	**3.628**
opamp_SR	215	600	200	34.8	18.2	**2.604**	**37.3**	**9.5**	**2.515**
compar_bw	639	1502	500	246.2	56.9	**16.010**	**73.7**	**23.0**	**16.458**
opamp_PM	215	600	200	63.9	18.3	3.678	**26.7**	**9.4**	**2.441**
opamp_BW	215	600	200	34.9	18.3	**1.800**	**31.6**	**9.6**	**2.084**
mem	385	7500	2500	failed	failed	failed	**422.4**	**78.3**	**0.480**
senseamp_delay	125	3750	1250	failed	failed	failed	**286.0**	**38.4**	**5.135**

Life Planning as a 35 Year Old (2013)

“I kinda miss Europe (my wife does too)”
“Berlin is a cool city. Lotsa art happening”

So: “let’s try Berlin for a few months” ★
That was 18 months ago!

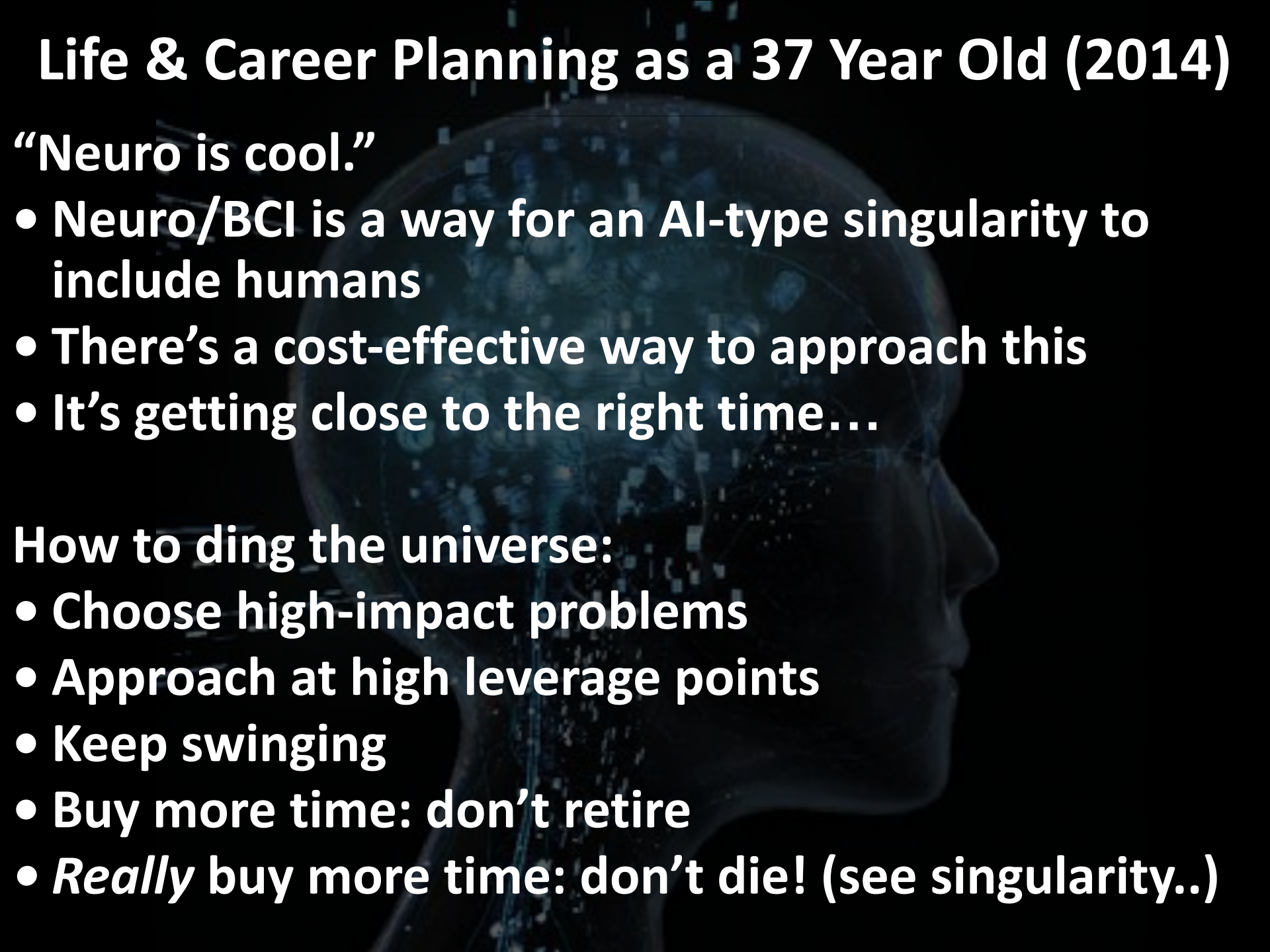
Life&Career Planning as a 35.5 Year Old (2013)

"Bitcoin is cool. Blockchain in particular."
"The art world has some specific challenges."
So, what if…

- That's my *other* venture now – Keidom
- And it's not just art. It's *ownership*.

(Not 100% on it: babies to feed, salary=good)

Life & Career Planning as a 37 Year Old (2014)



"Neuro is cool."

- Neuro/BCI is a way for an AI-type singularity to include humans
- There's a cost-effective way to approach this
- It's getting close to the right time…

How to ding the universe:

- Choose high-impact problems
- Approach at high leverage points
- Keep swinging
- Buy more time: don't retire
- *Really* buy more time: don't die! (see singularity..)

A Review

Looking back,
I realize I can identify my career's turning points: 

I've *chosen* those turning points in the last 10+ years.

- (vs stumbled onto, or worse, had them decided for me)
- *Intentional career & life design.*

- Guided by my passions, what might be fun/cool, and the future I want for myself and humanity
- Design process includes asking questions, writing down goals & constraints, evaluating possibilities
- They took courage to implement. Status quo = easy.
- AI has always been a passion. Perhaps fortunate since AI opens many doors☺️